

Productivity and Economic Impacts of Feedgrade Antimicrobial Use in Pork Production

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Summary: There is growing concern among public health experts regarding the diminishing efficacy of antimicrobial therapy in human and veterinary medicine, and some have called for a ban on subtherapeutic antibiotic use in pork production. This paper develops an econometric analysis to identify the economic contributions of subtherapeutic antimicrobial use in swine production. Using data from the 1990 and 1995 NAHMS National Swine Surveys, linear regression models were estimated to identify the relationships between feedgrade antibiotic use and other factors of production on productivity and mortality in the grower/finisher phase. Empirical results indicate that average daily gain and feed conversion ratio are improved by 0.9% and 2.3%, respectively, while grower/finisher mortality is improved 0.29 percentage points. The results also suggest that tailored rations can serve as a substitute for subtherapeutic antibiotics. Additional research on the relationships between productivity and feedgrade antibiotics in modern U.S. pork production systems is warranted.

Keywords: feedgrade antibiotics, productivity, economic benefit

Introduction: Since the early 1950's, subtherapeutic antibiotics have been widely used to promote the growth and overall health of livestock. However, there is growing concern among health officials, physicians, veterinarians, and the public at large regarding the diminishing efficacy of antimicrobial therapy in human and veterinary medicine. Many fear that subtherapeutic antibiotics administered in feed over the course of an animal's production cycle contribute to the accelerated development of antibiotic resistance in bacteria. Understanding the productivity and economic value of feedgrade antibiotics to the livestock industry is a critical first step when considering policies to reduce or eliminate the availability of this input to producers. This paper attempts to estimate the implicit value of subtherapeutic antibiotics to swine producers, and to identify gaps in the knowledge base.

The benefits associated with subtherapeutic antibiotics use in swine production are thought to include improvements in average daily gain (ADG), feed conversion ratio (FCR), farrowing rate, baby pig survival, and mortality rate. Cromwell (2000) estimates the net economic benefit of subtherapeutic antibiotic use from post-weaning through the grow/finish (G/F) phase of production to be \$2.99 per market hog. A recent study by Hayes et al. (1999) estimates that a ban on subtherapeutic antibiotics would decrease producers' profits initially by \$4.17 per head, and by \$0.79 per head after 10 years. Hayes et al. estimates are based on the European experiences of a ban on use and may be inappropriate for the U.S. pork production system.

Material and Methods: The data used in this study comes from the 1990 and 1995 NAHMS National Swine Surveys. These surveys were designed to provide statistically valid estimates of key parameters relating to the health, management, and productivity of the U.S. swine herd (USDA 1992, 1996). Data from these two surveys were merged to improve sample size. Sampling differences between the two surveys made it necessary to approximate several variables relating to productivity and antibiotic use so that both datasets could be used.

Linear regression was used to identify relationships between productivity in the G/F unit, feedgrade antibiotic use, and other potentially relevant factors of production. Separate models were estimated for ADG, FCR, and G/F phase mortality rate (MR) using a backward-stepwise maximum likelihood estimation procedure, where candidate explanatory variables with *p*-values less than 0.30 were retained. Following an approach employed by Losinger (1998 a,b), several explanatory variables were forced into the models to control for geographic region, size and type of operation, the year the operation was surveyed by NAHMS, and the average number of days spent in the G/F unit. The data used to estimate the MR model were taken exclusively from the 1995 NAHMS dataset, since several key variables were missing from the 1990 dataset that were important for this model. Mortality rate is defined as the percentage of pigs that died in the grower finisher unit over a six-month period. The antibiotic variables considered for inclusion in the models are the number of different feedgrade antibiotics used and the number of days antibiotics are fed during the G/F phase.

Results: The estimated productivity models suggest that both ADG and FCR are improved as the number of days that antibiotics are used in feed is increased, though using more than one antibiotic implies higher (poorer) FCR. The interaction between the number of antibiotics used and the number of diseases diagnosed in the G/F unit also has a negative impact on ADG, though this effect may be capturing the response of producers to use antibiotics as a preventive when there is an increase in the prevalence of disease.

Variables explaining MR suggest that reductions in mortality rate are associated with feeding antibiotics over a longer period of time. The effect of using two antibiotics in the presence of disease in the G/F unit is an increase in the MR, while vaccination against disease lowers MR. The lowering of MR is also significantly ($p = 0.006$) associated with weaning piglets at an older age.

To evaluate the effect of antibiotics-related variables as a group on productivity and mortality, a joint hypothesis test was performed with exclusion restrictions imposed on the relevant variables. The test compares the significance of two models: one with the antibiotic variables and one without. The results of the F -tests suggest that the only model where the antibiotic variables are jointly statistically significant with a reasonable level of significance ($p < 0.10$) is the ADG model. The F -test results for the FCR ($p = 0.229$) and MR ($p = 0.223$) models suggest that the antibiotic variables are jointly significant at a 0.25 level of statistical significance.

Using the results from the regression models, we can estimate the effect of subtherapeutic antibiotics on the performance of G/F pigs in percentage terms. For a medium-sized farrow-to-finish producer, it is estimated that subtherapeutic antibiotics improve ADG and FCR by 0.9% and 2.3%, respectively, while MR in the G/F unit is improved 0.29 percentage points. To express these performance figures in economic terms, the model results were evaluated using a swine enterprise budgeting model developed by Miller, et al. (2001). Given these improvements in ADG, FCR and MR, the estimated increase in annual returns above total costs from antibiotics for a 1,020-head finishing barn is \$3,424 per year, or \$1.26 per pig marketed.

Another interesting result from the ADG and FCR models is the substitution effect between feedgrade antibiotics and the number of rations used during the G/F phase. Increasing the number of rations improves ADG and FCR, though this effect is diminished when antibiotics are used. The economic implications of this result suggest that when five or more rations are used, the net economic benefit of using feed-grade antibiotics is negative. These results show that tailoring rations specifically to meet the dietary needs of pigs throughout the G/F phase can serve as a substitute for subtherapeutic antibiotics. This implies that producers managing finishing operations where diets are tailored to meet pig growth needs over time will not see the same benefits from using antibiotics as those who feed a small number of different diets.

Our results do not take into account the added variability in ADG and FCR that is likely to be observed when subtherapeutic antibiotics are not used. This might be critically important.

Discussion: Our results suggest that the economic impact of the use of feedgrade antibiotics in G/F units in the U.S. is sufficiently high that pork producers might be reluctant to produce pigs without this input. However, we also found that there is

the potential for substantial substitutability with this input and other production inputs. The potential trade off in applying some alternative inputs may be the added complexity associated with the use of these inputs. Human capital may be an important part of these input tradeoffs, and one which is not easily substituted.

Data manipulations and assumptions were needed to obtain these results. The extent to which these manipulations obscure the real relationships that exist between feedgrade antibiotic use and productivity measures in pork production is unknown. Given the widespread use of feedgrade antibiotics within the U.S. pork industry, it is clear that most producers believe their profits are higher with use than they would be otherwise. There is a need for controlled feeding trials that will carefully quantify the relationships between growth promoting antibiotic use and productivity measures carried out in field situations reflective of current U.S. production systems, including current genetics, size of operations, current feeding practices, typical disease and other environmental pressures, among other factors. Additionally, there is a need for assessing the risk to human health of the use of feedgrade antibiotics in swine production.

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